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Fenton

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[54] **THIN PROFILE VERTICALLY ORIENTED PROBE ADAPTER WITH CODE DISASSEMBLY CAPABILITY**

[75] Inventor: **James M. Fenton**, Tigard, Oreg.

[73] Assignee: **Tektronix, Inc.**, Beaverton, Oreg.

[*] Notice: This patent is subject to a terminal disclaimer.

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[22] Filed: **Jun. 17, 1998**

[51] **Int. Cl.**[7] **G01R 31/02**

[52] **U.S. Cl.** **324/754**; 324/761

[58] **Field of Search** 324/754, 761, 324/762, 765; 439/55; 361/683, 777, 791

[56] **References Cited**

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4,417,204	11/1983	Dehmel et al.	324/754

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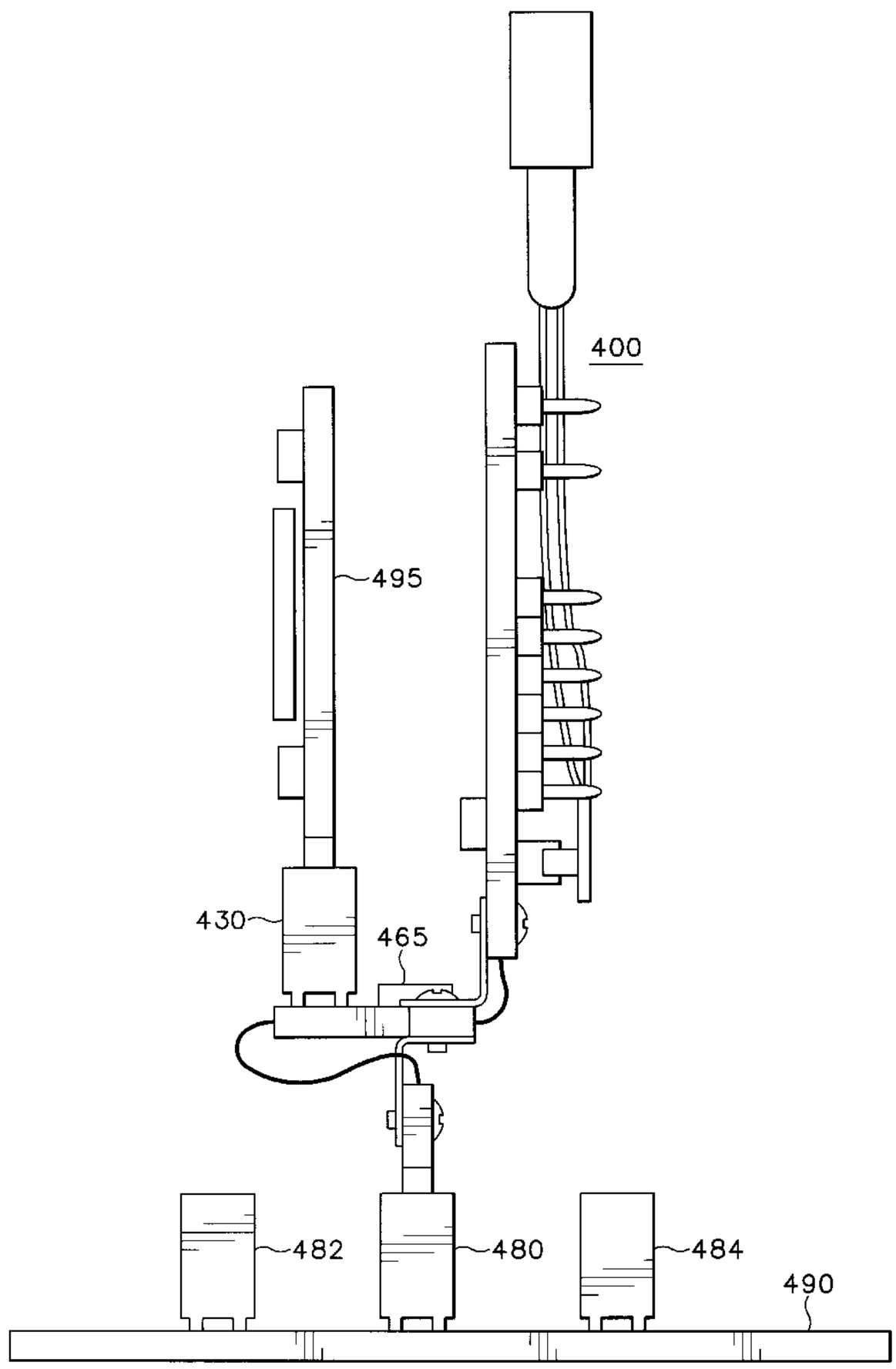
Intel Corporation, Jul. 31, 1996, "Accelerated Graphics Port Interface Specification" Revision 1.0.

Primary Examiner—Vinh P. Nguyen
Attorney, Agent, or Firm—Thomas F. Lenihan

[57] **ABSTRACT**

An apparatus for providing a probing interface for a circuit under test exhibits a relatively narrow profile and a vertical orientation so that it does not block access to connectors in adjacent slots. The vertical orientation is made possible by the use of a circuit material comprising alternate sections of flexible material and rigid material. Advantageously, the signal lines between the circuit card under test and its motherboard are direct and relatively short, and the probing connection points are isolated from the direct signal lines by a plurality of isolation resistors. The probing adapter includes the capability of monitoring the bus of the system under test and disassembling monitored AGP codes.

6 Claims, 6 Drawing Sheets



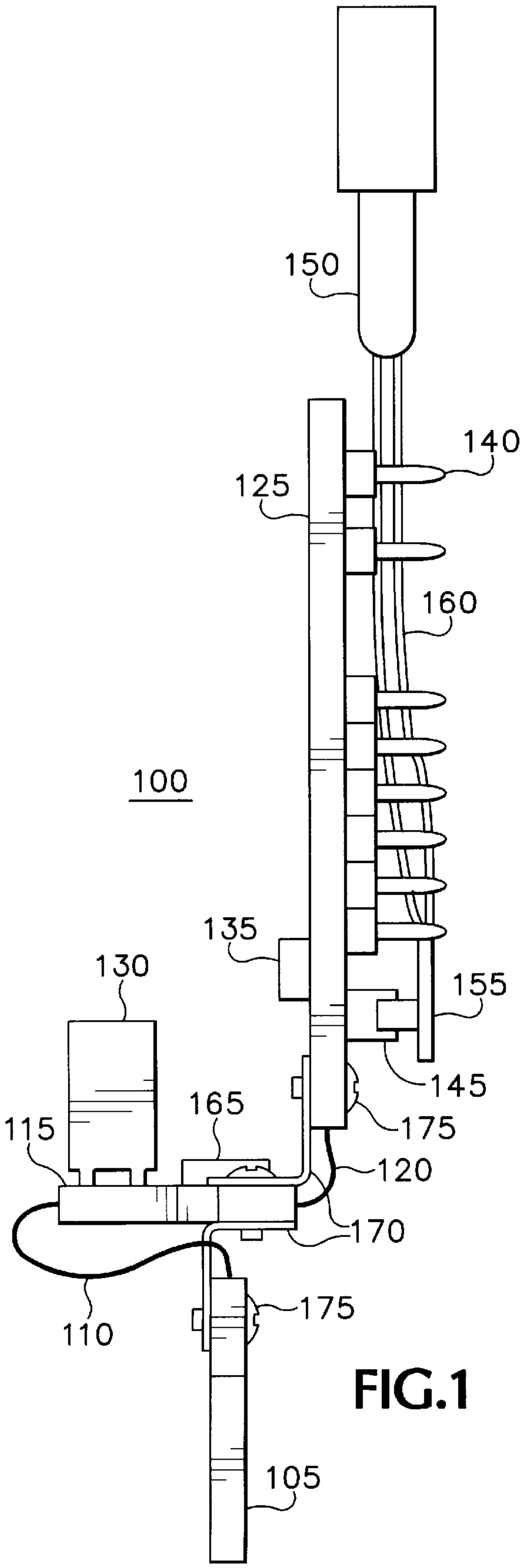

150
140
125
160
100
135
130
155
145
165
175
115
120
170
175
110
105

FIG.1

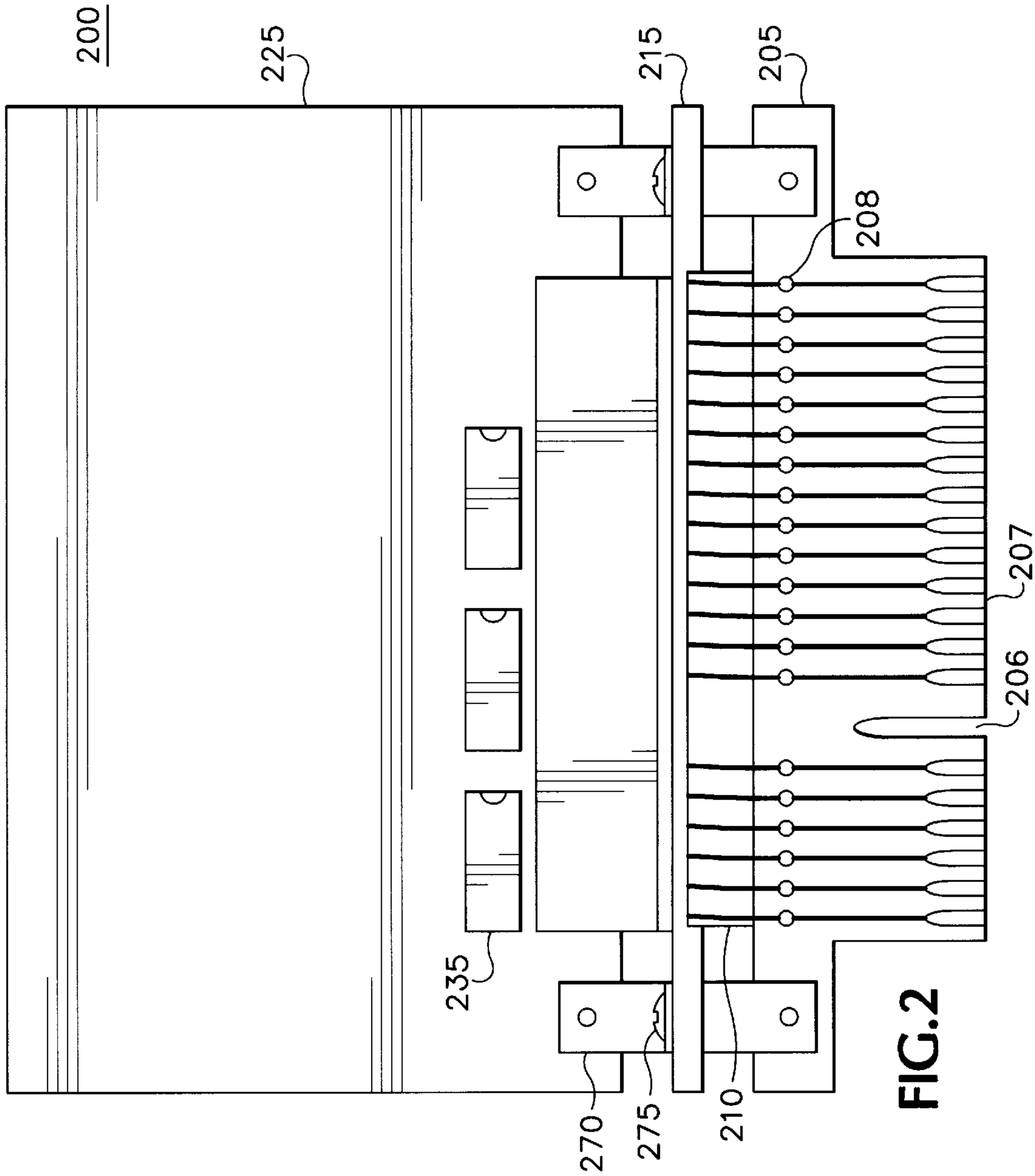


FIG.2

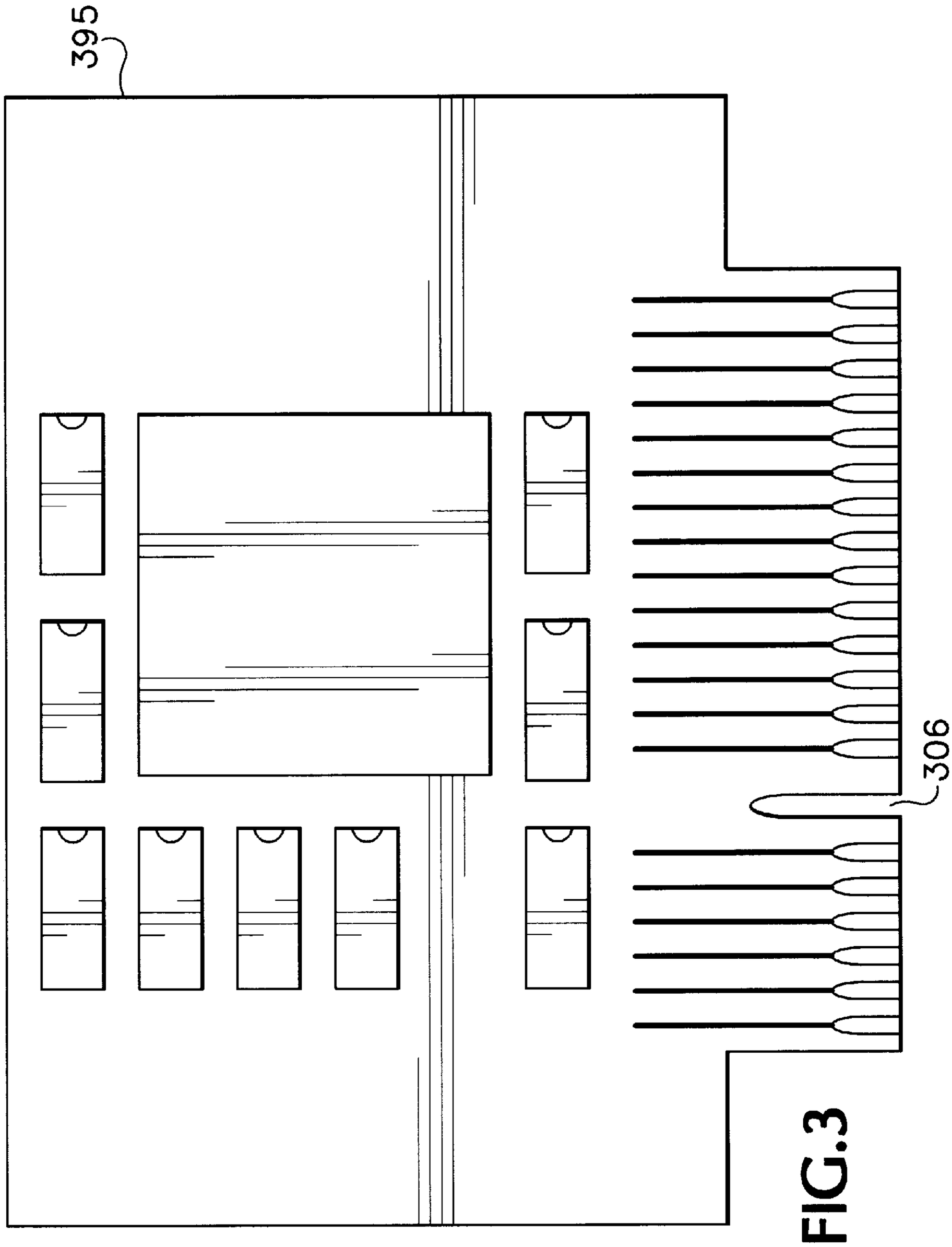


FIG.3

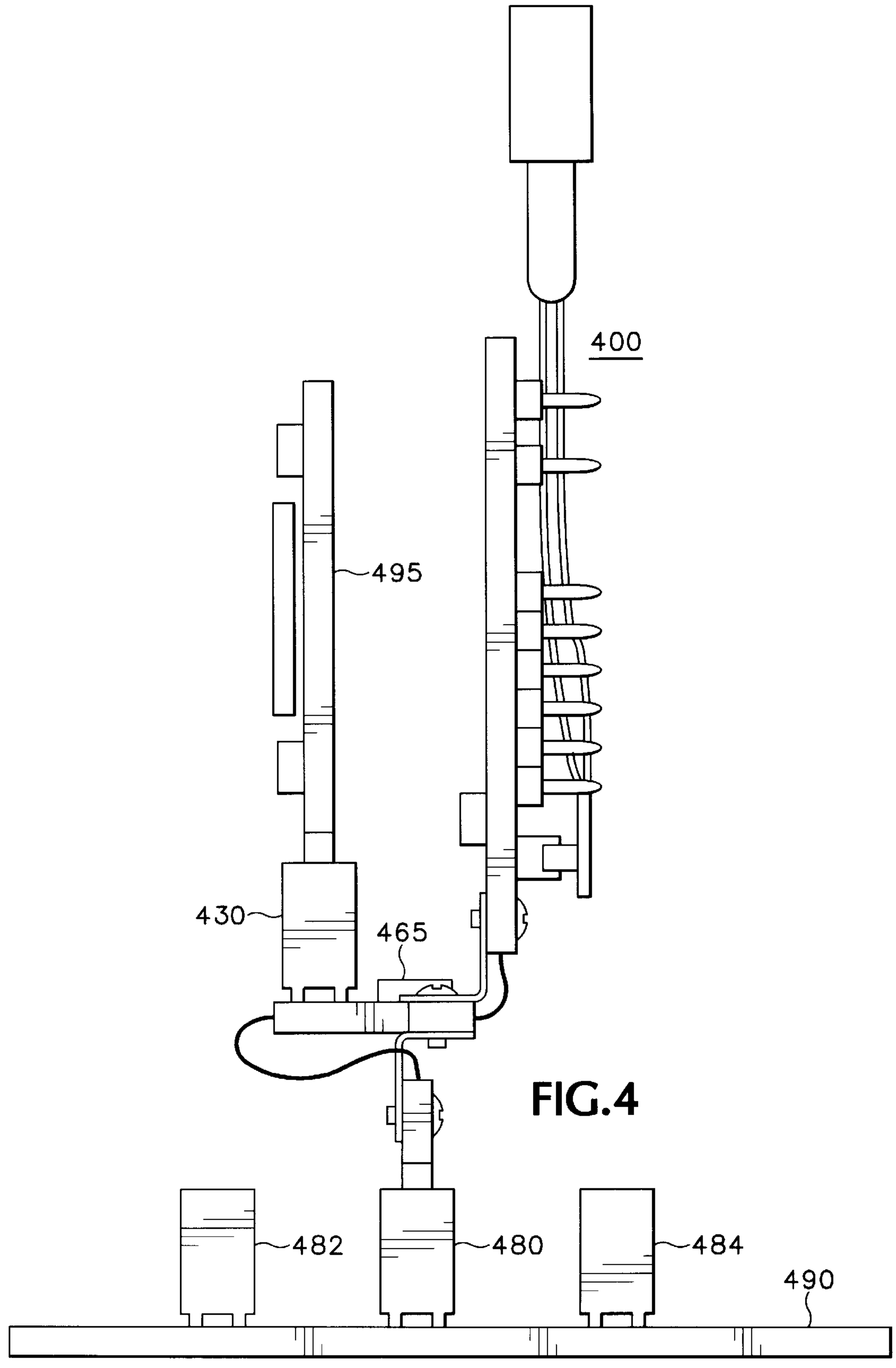


FIG.4

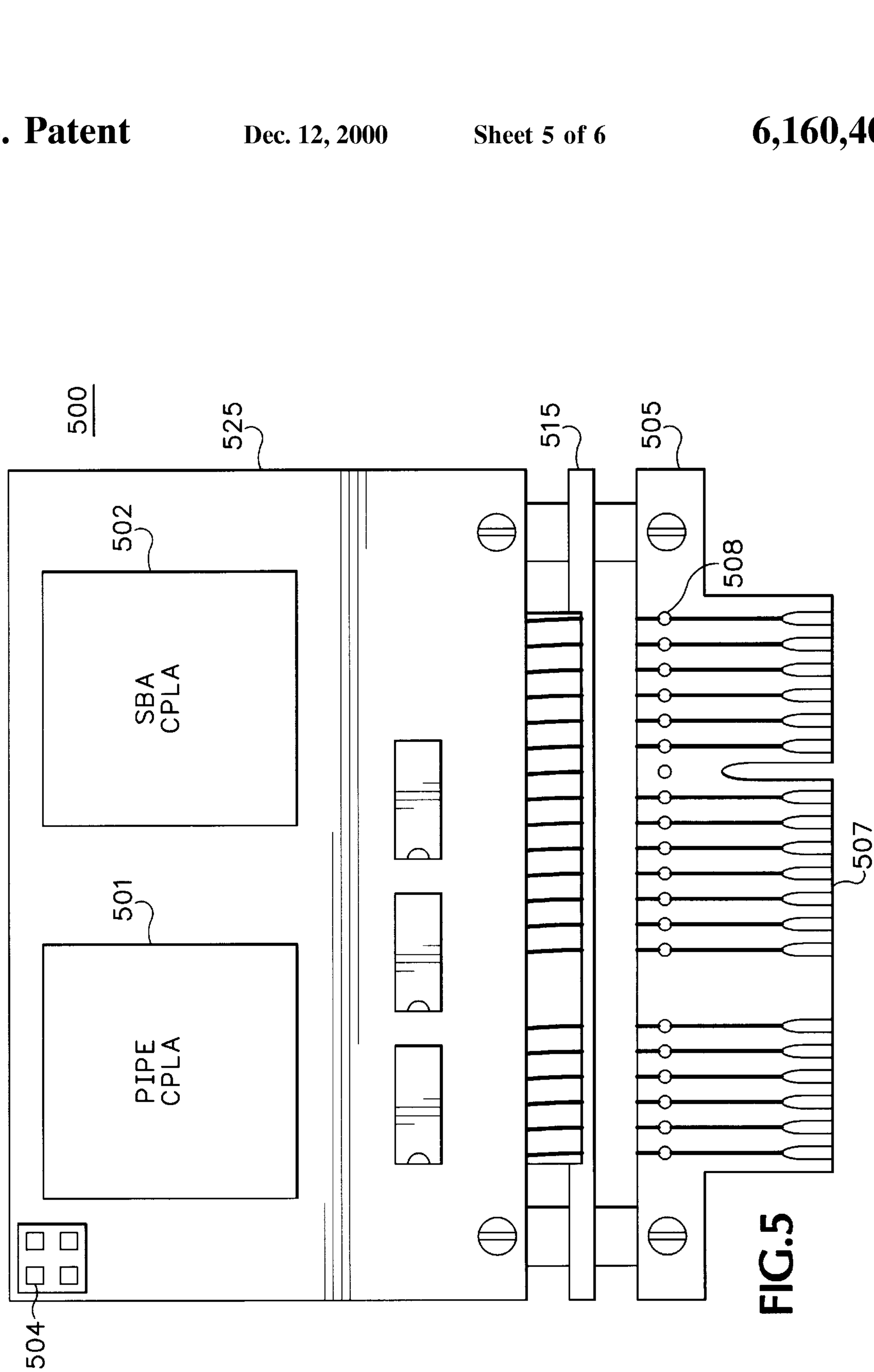


FIG.5

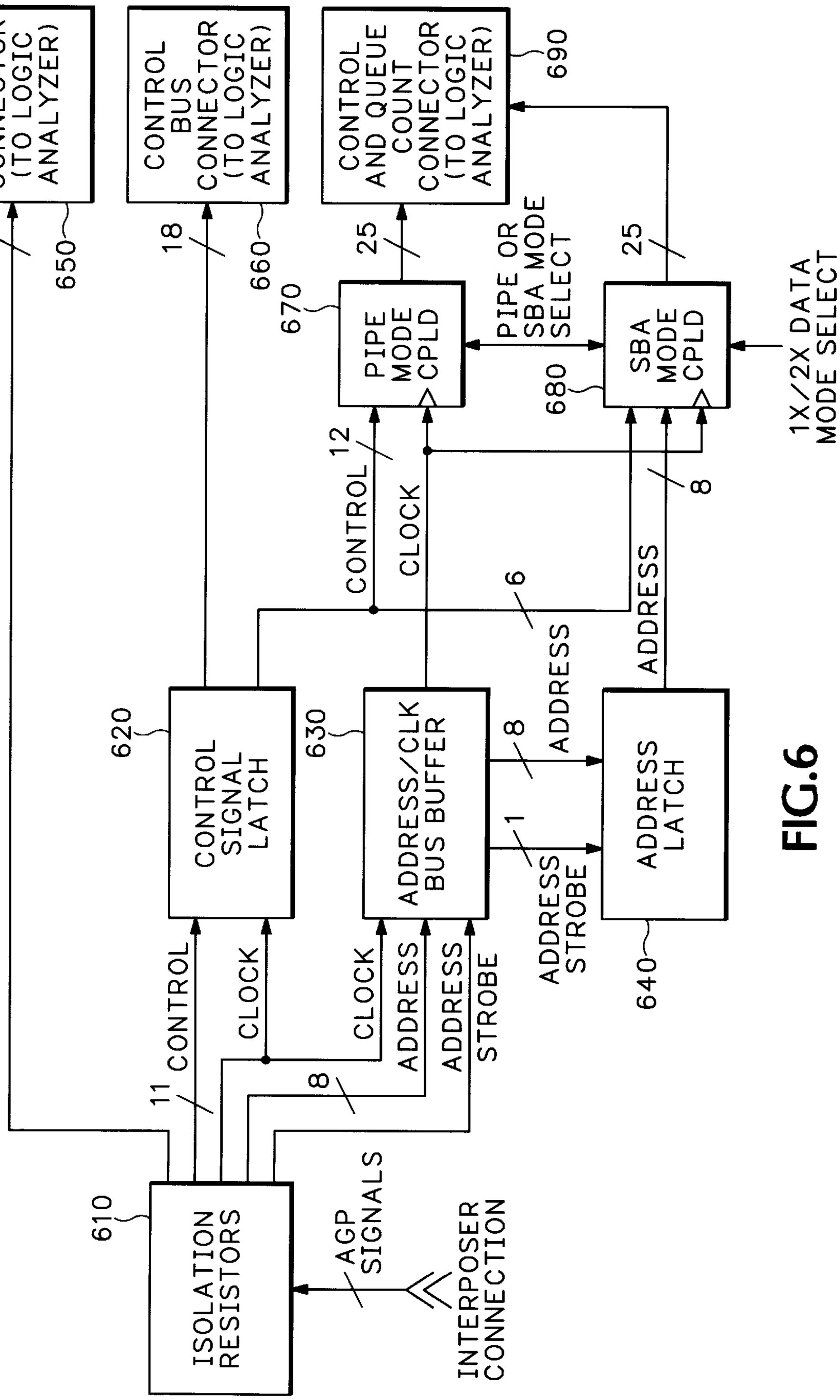

DATA BUS CONNECTOR (TO LOGIC ANALYZER)
CONTROL BUS CONNECTOR (TO LOGIC ANALYZER)
CONTROL AND QUEUE COUNT CONNECTOR (TO LOGIC ANALYZER)
690
32
650
18
660
25
25
670
PIPE MODE CPLD
PIPE OR SBA MODE SELECT
SBA MODE CPLD
680
1X/2X DATA MODE SELECT
12
CONTROL
CLOCK
6
8
ADDRESS
620
CONTROL SIGNAL LATCH
630
ADDRESS/CLK BUS BUFFER
8
ADDRESS
1
ADDRESS STROBE
ADDRESS LATCH
640
11
CONTROL
CLOCK
8
CLOCK
ADDRESS
ADDRESS
STROBE
610
ISOLATION RESISTORS
AGP SIGNALS
INTERPOSER CONNECTION

FIG.6

THIN PROFILE VERTICALLY ORIENTED PROBE ADAPTER WITH CODE DISASSEMBLY CAPABILITY

FIELD OF THE INVENTION

The subject invention concerns the field of expander cards in general, and specifically concerns probe adapters suitable for use with logic analyzers.

BACKGROUND OF THE INVENTION

When using many electronic test and measurement equipment products, such as, oscilloscopes, logic analyzers, communication systems protocol analyzers, spectrum analyzers, and the like, to troubleshoot a circuit under test, it is quite common to employ a circuit card extender to elevate a particular circuit card an thereby facilitate connection of test probes to the circuit under test (sometimes referred to as a System Under Test, or SUT). In the distant prior art, this feature was implemented by providing a board with a card edge connector on one end, a card edge receptacle on the other end, and a plurality of printed traces running straight across the board from the card edge to the receptacle. Probing was performed directly on the circuit board under test.

A probing adapter is nonintrusive hardware that allows a logic analyzer to acquire data from a bus in its own operating environment with little, if any, effect on the target system. A probing adapter comprises a circuit board and a socket for a circuit card to be tested. A probing adapter plugs into a bus receptacle on the target system and signals from the system bus flow through the probing adapter to a logic analyzer. Modern probing adapters must support logic analyzers which have the capability of monitoring a large number of channels (for example 136 channels), simultaneously. Consequently, in addition to elevating the circuit under test from its motherboard, by interposing between the circuit under test and its normal connector on the motherboard, a probing adapter also provides connection points (i.e., sockets) for high density multiconductor probes.

Unfortunately, prior art probing adapters suffered from several disadvantages. Among these disadvantages are: signal reflections caused by impedance mismatches due to the use of the connectors to turn the probe adapter from a vertical orientation to a horizontal orientation for use, and blocking of adjacent slots due to the horizontal orientation of the probing adapter. Moreover, prior art probing adapters do not have the capability to disassemble the AGP (Accelerated Graphics Port) code at the adapter itself. A probe adapter exhibiting these disadvantages is the FSAGP 32TE AGP Probe manufactured for Hewlett Packard Inc. by FuturePlus Systems Corporation, Colorado Springs, Colo.

What is needed is a probing adapter which does not block adjacent slots, which does not introduce impedance mismatches which would otherwise cause reflective events, and which has the capability to disassemble monitored AGP codes.

SUMMARY OF THE INVENTION

An apparatus for providing a probing interface for a circuit under test exhibits a relatively narrow profile and a vertical orientation so that it does not block access to connectors in adjacent slots. The vertical orientation is made possible by the use of a circuit material comprising alternate sections of flexible material and rigid material. Advantageously, the signal lines between the circuit card under test and its motherboard are direct and relatively short, and the probing connection points are isolated from the direct signal lines by a plurality of isolation resistors. The probing adapter includes the capability of monitoring the bus of the system under test and disassembling monitored AGP codes.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** shows an embodiment of a thin profile vertically oriented probing adapter according to the invention.

FIG. **2** shows the embodiment of FIG. **1** in use with a circuit card under test.

FIG. **3** shows a front view of the embodiment of FIG. **1**.

FIG. **4** shows a simplified card representing a circuit to be tested.

FIG. **5** shows a rear view of the embodiment of FIG. **1**.

FIG. **6** shows, in block diagram form, suitable circuitry for a probing adapter according to the subject invention

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1**, a thin (or narrow) profile vertically oriented probing adapter **100** is shown. Adapter **100** comprises a first rigid section **105** having connector pads (not shown in FIG. **1**) formed thereon for connection to a mating receptacle on a motherboard (also not shown in FIG. **1**). Adapter **100** further comprises a flexible section **110** for transferring electrical signals between first rigid section **105** and a second rigid section **115**, perpendicularly mounted with respect to board section **105**. Adapter **100** further comprises a second flexible section **120** for coupling electrical signals between second rigid section **115** and a third rigid section **125**.

Adapter **100** includes a mating card edge receptacle **130** mounted on second rigid section **115** for receiving a circuit card to be tested, and for supporting the circuit card to be tested in the same vertical orientation it exhibits when plugged directly into the motherboard. Adapter **100** is preferably made using a "rigid-flex" circuit material, which is readily available for a variety of circuit board manufacturers.

Many high reliability applications call for durability and high temperature which often require a rigid-flex circuit. A rigid flex is basically a flexible circuit integrated into a multilayer rigid construction. The flexible layers extend through the rigid portions allowing the holes to be plated through directly from the outside rigid layers to the internal flex layers. This is often the best solution from a packaging standpoint. The rigid sections are ideal for component and connector mounting, while protruding flexible portions allow flexing for installation and there are no connectors required at the flex-to-board interfaces. Mechanically you get the best of both worlds. The flexible portion of this material passes through the interior of the rigid sections and is superior to using connectors arranged at right angles to pass signals between perpendicularly mounted circuit boards. This is so because the impedance of the signal lines is maintained substantially constant and thus no reflective event transition is introduced. The use of rigid-flex techniques also avoids the added capacitance which would accompany the use of right angle connectors.

Note that the distance between the lower end of rigid section **105** and receptacle **130** is relatively short, about 1.5 inches in actual practice. This relatively short distance advantageously reduces the round trip time delay for the signals passing between the circuit under test and the

motherboard. t is also important to note that there are no intervening components between the motherboard and the circuit under test.

Rigid section **125** may have electronic components **135** mounted thereon for specific purposes when testing specific boards. Such components are not necessary to the invention and will not be described. Rigid section **125** may also have one or more test points **140** mounted thereon for individual probing, but the main connection point for test and measurement is via one or more high density connectors **145**. A probe **150**, having a right angle head **155** is shown connected to high density connector **145**. A bundle of test probe leads **160** connects between head **155** and probe body **150**.

It is important to isolate the test probe from the circuit under test so as not to introduce significant loading. In this regard, each of the pins of receptacle **130** is coupled to probe head **155** via a respective series connected isolation resistor, generally designated **165**. The value of each of the plurality of series connected isolation resistors **165** is preferably **180** ohms. Probing adapter **100** is held in position by mounting brackets **170** and screws or rivets **175**.

The thin profile enables a probing adapter according to the subject invention to be used where the spacing between connectors on the motherboard is as little as 0.8 inches. This feature is extremely important because it allows testing of the circuit under test while the card in the next adjacent slot is plugged into its receptacle in the motherboard. No other probing adapter allows such operation.

A front view of probing adapter **100** of FIG. **1** is shown in FIG. **2** wherein elements which bare similar numbers to elements in FIG. **1** serve similar functions which will not be described again. First rigid section **205** of probing adapter **200** includes a keyway **206** for guiding insertion into a receptacle on the motherboard, and for preventing backwards insertion. Rigid section **205** has connector pads generally designated **207** plated thereon to make electrical connection to the receptacle pins when probing adapter **200** is inserted into the receptacle (not shown in this FIGURE) on the motherboard. Each of the signals on each of connector pads **207** are conveyed to the interior of rigid section **205** by way of a via (i.e., a plated through hole) generally designated **208** which makes contact with both the printed trace leading to a contact pad **207** and to the flexible circuit material occupying an interior layer of rigid section **207**.

FIG. **3** shows a simplified representation of a circuit board to be tested. Note that it has the same keyway **306** in the same position for mating with its receptacle on the motherboard.

Referring to FIG. **4**, a probing adapter **400** according to the invention is shown inserted into a receptacle **480** of a motherboard **490**. Elements which bare similar numbers to elements in FIG. **1** serve similar functions which will not be described again. Note that a circuit board to be tested (for example, the circuit board of FIG. **3**) has been inserted into test receptacle **430**. Circuit board **495** is coupled to its motherboard without any intervening components over a connection run which is only about 1.5 inches in length, and should function in the same manner as if it were plugged into its motherboard receptacle directly. It is important to note from FIG. **4** that circuit boards may be plugged into adjacent motherboard receptacles **482** and **484**, a valuable feature that was hereto fore unavailable to the test engineer.

FIG. **5** is an illustration of the rear side of probing adapter **100** of FIG. **1**. Probing adapter **500** preferably includes two CPLAs (Complex Programmable Logic Arrays). The PIPE CPLA **501** keeps track of AGP bus activity when the circuit under test is operating in 1× or 2× PIPE mode. The SBA CPLA **502** tracks bus activity when the circuit under test is operating in 1× or 2× SBA mode. Jumpers **504** on probing adapter **500** allow the user to choose PIPE or SBA mode as well as 1× or 2× mode. Each of CPLA integrated circuits **501** and **502** is coupled to the system bus through the above-mentioned series coupled isolation resistor array to prevent loading of the bus. The CPLA integrated circuits monitor the bus, evaluate the state of the bits on each clock cycle and translate the bits into assembly language for display on the screen of the logic analyzer to allow the user to more easily debug the hardware or software in the system under test.

Referring to the block diagram of FIG. **6**, AGP signals are applied at the input of the probing adapter (also referred to as the interposer connection), and are coupled to the remainder of the circuitry by isolation resistors **610** (mentioned above with respect to reference numeral **165**). The isolation resistors couple the AGP signals to Data Bus Connector **650**, Control Signal Latch **620**, Address/Clock Bus Buffer **630**, and Address Latch **640**. Address Latch **640** provides address signals to SBA Mode CPLD **680**. Control Signal Latch **620** provides control signals to Control Bus Connector **660** which in turn provides these signals to an externally connected logic analyzer (not shown). Control Signal Latch **620** also provides control signals to PIPE mode CPLD **670**, and to SBA Mode CPLD **680**. Address/Clock Bus Buffer .**630** provides clock signals to Pie Mode CPLD **670** and SBA Mode CPLD **680**. PIPE mode CPLD **670** provides control and queue counter signals to Control and Queue Counter connector **690** for further connection to the aforementioned logic analyzer.

Thus, there has been described a probing adapter device for connecting to and supporting in a vertical direction, a circuit under test. As a result of using the subject invention, one can test the circuit under operating conditions with boards inserted into adjacent receptacles on the motherboard, and one can view disassembled code on the screen of the logic analyzer.

While the invention has been described with respect to connection to a logic analyzer, it is herein recognized that it is also applicable to other types of test and measurement instruments, such an oscilloscope, a spectrum analyzer, or the like, and such modification is deemed to lie within the scope of the following claims.

What is claimed is:

1. A probe adapter for providing a testing interface between a circuit board under test and a test instrument, comprising:

a first rigid circuit board member for connecting to a first receptacle on a motherboard;

a second rigid circuit board member mounted perpendicular to said first rigid circuit board member for supporting a second receptacle for receiving a circuit under test and supporting said circuit test in a vertical orientation parallel to said first rigid circuit board member;

a first flexible circuit board member for connecting signals between said first and second rigid circuit board members,

a third rigid circuit board member for coupling signals from said receptacle supporting said circuit board under test to said test instrument;

a second flexible circuit board member for coupling signals between said second and third rigid circuit board members; and

a circuit for monitoring and acquiring said signals, wherein said signals represent program code and data,

said circuit evaluating said signals, providing qualifier signals to enable said test instrument to disassemble said program code, and said circuit determining when to latch said program code and said data for transfer to said test instrument.

2. The circuit of claim **1** further including

a plurality of isolation resistors, each of which is coupled in series between contact pins of said receptacle for supporting said circuit board under test and said second flexible circuit board member.

3. The circuit of claim **2** wherein,

said circuit includes a CPLA for processing PIPE data.

4. The circuit of claim **2** wherein,

said circuit includes a CPLA for processing SBA data.

5. Th e circuit of claim **2** wherein,

said circuit includes:

a first CPLA for processing PIPE data;

a second CPLA for processing SBA data; and

selection means for selecting between said first and second CPLAs.

6. The circuit of claim **5**, wherein

said first and second CPLAs operate in 1× and 2× mode; and

said circuit includes further selection means for selecting between said 1× and 2× modes.

* * * * *